VALID UNTIL 5/4/07

# APPENDIX 8 - LOCOMOTIVES

Below is additional information pertaining to the On-Road Heavy-Duty Vehicle (HDV) category under AQMD's FY 2007 Carl Moyer Program (CMP). All information in Program Announcement (PA) # PA2007-08 and this Appendix apply. For additional detail regarding this program category, refer to CARB's 2005 CMP Guidelines. In the case of any conflict between CARB guidelines and AQMD criteria, the more stringent criteria will prevail.

It is the Applicant's responsibility to check with AQMD's CMP web page for program clarifications, changes and updates. This page may be accessed by clicking the link on AQMD's home page at http://www.aqmd.gov/tao/implementation/carl_moyer_program_2001.html.

## CARB MOYER PROGRAM RESOURCES

Applicants are highly encouraged to review CARB guidelines for additional requirements of the CMP. CARB guidelines are incorporated into AQMD's Moyer Program by reference. 2005 CARB guidelines may be downloaded from:

http://www.arb.ca.gov/msprog/moyer/guidelines/revisions05.htm

On this web page, there are links to the four parts of the CARB 2005 CMP guidelines. These parts are described below for easy reference.

- Part I provides the Executive Summary, Program Overview and Administrative Requirements primarily applicable to air districts) for CARB's Carl Moyer Program. The link to Part I is http://www.arb.ca.gov/msprog/moyer/guidelines/2005_Carl_Moyer_Guidelines_Part1.pdf

- Part II provides the Project Criteria for each program category. The link to Part II is http://www.arb.ca.gov/msprog/moyer/guidelines/2005_Carl_Moyer_Guidelines_Part2.pdf

- Part III provides the Agricultural Assistance Program guidelines. Link to Part III at http://www.arb.ca.gov/msprog/moyer/guidelines/2005_Carl_Moyer_Guidelines_Part3.pdf

- Part IV is the Appendices section of the guidelines. The link to Part IV is http://www.arb.ca.gov/msprog/moyer/guidelines/2005_Carl_Moyer_Guidelines_Part4.pdf . This section includes the following Appendices.

    - Appendix A – Acronyms
    - Appendix B – Tables for Emission Reduction and Cost-Effectiveness Calculations
    - Appendix C – Cost-Effectiveness Calculation Methodology
    - Appendix D – Example Calculations
    - Appendix E – Description of Certification and Verification Executive Orders
    - Appendix F – Retrofit Emission Control Strategies
    - Appendix G – Description of Functional Equivalency of Non-Original Equipment Manufacturer Repowers and Rebuilt Engines for use in Repowers

**HIGHLIGHTS FOR 2007**

- Emission reductions obtained through Carl Moyer Program projects must not be required by or used to comply with any federal, state or local regulation, memorandum of agreement/understanding with a regulatory agency, settlement agreement, mitigation requirement, or other legally binding document. Inclusion in a rail yard or port emission reduction plan, lease agreement, or other voluntarily adopted strategy does not exclude a locomotive project from funding eligibility, if such a project is not otherwise required.
- Locomotive operators utilizing an alternative emission control plan (AECP) to comply with California's locomotive low-sulfur diesel fuel requirements shall not be eligible for Carl Moyer Program funds.
- Beginning January 1, 2007, all diesel locomotive projects must use ARB low-sulfur diesel fuel. Emission reductions and costs associated with use of ARB low-sulfur diesel shall not be included in project cost-effectiveness calculations.
- The project cost-effectiveness limit is $14,300 per weighed ton of NOx, PM and ROG emissions reduced. A four (4) percent capital recovery factor is used for the cost-effectiveness calculation.
- Cost-effectiveness calculations are based on particulate matter (PM10), oxides of nitrogen (NOx), and reactive organic gases (ROG). The formula is provided below. AQMD staff will calculate the NOx, PM and ROG emissions reductions and apply the formula during the evaluation process.

**Annualized Cost ($/year)**

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**NOx reductions + 20(combustion PM10 reductions) + ROG reductions (tons/year)**

- Applicants **must** provide **current** vendor quotes **obtained within the past 90 days** with their application to document the incremental cost of implementing the proposed technology. This will require documentation of both the baseline and low-emission project costs. Applicants can request funding up to the full differential cost between an optionally certified low-emission vehicle/engine/equipment and its new base standard emission equivalent; however, less may actually be awarded, depending on the results of the cost-effectiveness evaluation.

- Applicants **must** also provide documentation covering the past 24 months that justifies the activity level projected for the vehicles (i.e., hour-meter records, business records, fuel receipts, etc.).

- All projects must be operational within eighteen (18) months of contract execution or by May 31, 2009, whichever is earlier.

- The new engine/equipment/vehicle must not have been purchased prior to the effective date of the contract.

- Pre- and Post-Inspection of all vehicles/engines approved for funding is required, as well as verification of engine destruction. Payment will be made only after all inspections are completed and engine/vehicle destruction is verified.

- The project baseline emission rate for all locomotives in the SCAB subject to the South Coast MOU shall be equivalent to the Tier 2 emission rates identified for line-haul and switch locomotives in Table B-16.

- Funded projects must have at least 75 percent of the vehicle's annual miles traveled or gallons consumed within the South Coast Air Basin.

- Locomotive projects in the SCAB may not be included in the MOU fleet average emission rate compliance demonstration.

- Class I freight locomotive projects must have a minimum project life of ten years. All other locomotive projects have a minimum project life of three years. ARB may approve a shorter project life on a case by case basis. Projects with shorter lives may be subject to additional funding restrictions, such as a lower cost-effectiveness limit or a project cost cap.

- The maximum project life for a locomotive project is 20 years.

- Because of uncertainty in locomotive load factors, locomotive project activity must be based upon fuel consumption.

- A baseline engine in a repower project must be destroyed by scrapping or drilling a hole in the engine block rendering it inoperable unless prior approval for alternate disposition has been granted by ARB staff. At the discretion of the district, core charges are eligible for funding and, if included, must be part of the cost-effectiveness calculation.

- Class I locomotives subject to the South Coast MOU are eligible for Carl Moyer Program funding only if such locomotives are excluded from the fleet average emission rate calculations which demonstrate compliance with the MOU provisions. The baseline emission rates used to determine emission reductions and cost-effectiveness for these locomotive projects reflect the Tier 2 emission rates for line-haul and switch locomotives identified in Table B-16. Locomotives subject to the South Coast MOU which receive Carl Moyer Program funding are ineligible to receive fleet average emission credits.

- All locomotive new purchase or repower projects must include an electronic monitoring unit (EMU) to track activity and geographic location. Eligible EMUs include a geographic positioning system (GPS) unit, transponding device, automated vehicle locator (AVL), or other similar device. The EMU must be capable of providing complete digital information regarding total activity both within the air district and the State of California; this information shall be reported to air districts annually for the project life. The full purchase, installation and data summarization or transmittal costs associated with the EMU are eligible for Carl Moyer Program funding, though if requested, the added costs will be included when calculating project cost-effectiveness.

- All locomotive purchase and repower projects (except alternative technology switchers) must include purchase and installation of an automatic engine start-stop (AESS) idle reduction device (ILD) to reduce unnecessary engine idling if the locomotive is not already equipped with such a device and AESS installation is technically feasible. If not already required by a rule, regulation, MOU, or other legal mandate, the purchase and installation cost of an AESS is eligible for Carl Moyer Program funding, subject to the following limitations:
    - The Carl Moyer Program may provide actual equipment costs up to a maximum of $8,000 for a locomotive-specific AESS.
    - The Carl Moyer Program may provide the lower amount of actual installation costs of the AESS, up to a maximum of $3,400.
    - AESS emission reductions are calculated by applying the ILD emission reduction factors in Table B-17 to the reduced engine emissions.
    - All ILDs must comply with applicable durability and warranty requirements.

- AQMD reserves the right to disqualify any application that does not comply with all applicable requirements including submission of a complete application package. For Locomotive projects, this includes the main application as well as the information requested in Attachment 8 to the application.

- Please review CARB's CMP Guidelines, Part IV, Appendix E for a comprehensive description of certification Executive Orders for new engines and Verification Letters for retrofit devices.

**EVALUATION METHODOLOGY**

AQMD staff will evaluate all submitted proposals and make recommendations to the Governing Board for final selection of project(s) to be funded. Proposals will be evaluated based on the cost-effectiveness of emissions (NOx + ROG + 20*PM) reduced on an equipment-by-equipment basis, as well as a project's "disproportionate impact" evaluation (discussed below). Be aware of the possibility that due to program priorities and/or funding limitations, project applicants may be offered only partial funding, and not all proposals that meet minimum cost-effectiveness criteria may be funded.

In compliance with AB 1390, Firebaugh, the FY 2007 CMP requires that at least 50 percent of the funds be spent in areas that are disproportionately impacted by air pollution. CARB has issued broad goals and left the details of how to implement this requirement to each air agency. In the South Coast Air Quality Management District, the disproportionately impacted areas are defined by a weighted formula that includes poverty level, particulate matter (PM) exposure and toxic exposure. The process is described below:

1. All projects must qualify for the CMP by meeting the cost-effectiveness limits established in the PA.

2. All projects will be evaluated according to the following criteria to qualify for Disproportionate Impact funding:

    a. Poverty Level: All projects in areas where at least 10 percent of the population falls below the Federal poverty level based on the year 2000 census data, will be eligible to be included in this category, and

    b. PM Exposure: All projects in areas with the highest 15 percent of PM concentration will be eligible to be ranked in this category. The highest 15 percent of PM concentration is 46 micrograms per cubic meter and above, on an annual average, or

    c. Toxic Exposure: All projects listed in the Multiple Air Toxics Exposure Study in the South Coast Air Basin (MATES II) report[1] as having a cancer

[1] Multiple Air Toxics Exposure Study in the South Coast Air Basin (MATES II), SCAQMD, March 2000.

risk of 1,000 in a million and above will be eligible to be ranked in this category.

Data for the poverty level and PM and toxic exposures were obtained from the U.S. Census, the 1998 AQMD monitoring data and Mates II study respectively.

3. Fifty percent of the funding available for this PA will be allocated among proposals located in disproportionately impacted areas. If the funding for disproportionately impacted areas is not exhausted with the outlined methodology, then staff will return to the Governing Board for direction. If funding requests exceed 50 percent of the total available funding, then all qualified projects will be ranked based on their disproportionate impact. Each project will be assigned a score that is comprised of 40 percent for poverty level, and 30 percent each for PM and toxic exposures. Proposals with the highest scores will receive funding until 50 percent of the total funding is allocated.

   All the proposals not awarded under the fifty percent disproportionate impact funding analysis will then be ranked according to cost-effectiveness, with the most cost-effective project funded first and then in descending order for each funding category until the remainder of the Moyer Funds are exhausted. Some projects that exceed the cost-effectiveness ceiling may receive partial funding, depending on their rankings.

## ELIGIBLE COSTS

Eligible project costs (i.e., costs for which Moyer funding is requested) are limited to the incremental cost of a project to implement the reduced emission technology. Operation and maintenance costs are not eligible for CMP funding. Please refer to the Project Types section below for additional detail.

## PROJECT LIFE

Class I freight locomotive projects must have a minimum project life of ten years. All other locomotive projects have a minimum project life of three years. ARB may approve a shorter project life on a case by case basis. Projects with shorter lives may be subject to additional funding restrictions, such as a lower cost-effectiveness limit or a project cost cap.

The maximum project life for a locomotive project is 20 years.

## REPORTING AND MONITORING

All participants in the CMP are required to keep appropriate records during the full contract period. Project life is the number of years used to determine the cost-effectiveness and is equivalent to the contract life. All equipment must operate in the

AQMD for this full project life. The AQMD shall conduct periodic reviews of each project's operating records to ensure that the engine is operated as stated in the program application. Annual records must contain, at a minimum:

- Total miles traveled
- Total miles traveled in the South Coast Air Basin
- Annual fuel consumed
- Annual maintenance and repair information

Records must be retained and updated throughout the project life and made available for AQMD inspection. The AQMD may conduct periodic reviews of each vehicle/equipment project's operating records to ensure that the vehicle is operated as required by the project requirements.

## COST-EFFECTIVENESS EVALUATION DISCUSSION

Cost-effectiveness calculations are based on particulate matter (PM10), oxides of nitrogen (NOx), and reactive organic gases (ROG). AQMD staff will calculate the NOx, PM and ROG emissions reductions during the evaluation process. Only CMP funds are to be used in determining cost-effectiveness[2]. The one-time incentive grant amount is to be amortized over the project life (which is also the contract term) at a discount rate of 4 percent. The amortization formula (given below) yields a capital recovery factor (CRF), which, when multiplied by the initial capital cost, gives the annual cost of a project over its project term.

$$CRF = [(1 + i)^n (i)] / [(1 + i)^n - 1]$$

where

$i$ = discount rate (4 percent)
$n$ = project life (at least 3 years)

Table 8.1 lists the CRF for different project lives using a discount rate of 4 percent. Cost-effectiveness is determined by dividing the annualized costs of a project by the annual weighted emission reductions offered by the project.

[2] Unless the AQMD "buys down" the cost of the project by adding additional funding, in which case the total grant funding amount should be used for the cost-effectiveness calculation.

**Table 8.1 – Capital Recovery Factors (CRF) for Various Project Lives At 4 Percent Discount Rate**

| Project Life | CRF |
|---|---|
| 3 | 0.360 |
| 4 | 0.275 |
| 5 | 0.225 |
| 6 | 0.191 |
| 7 | 0.167 |
| 8 | 0.149 |
| 9 | 0.134 |
| 10 | 0.123 |
| 11 | 0.114 |
| 12 | 0.107 |
| 13 | 0.100 |
| 14 | 0.095 |
| 15 | 0.090 |
| 16 | 0.086 |
| 17 | 0.082 |
| 18 | 0.079 |
| 19 | 0.076 |
| 20 | 0.074 |

**Below are excerpts[3] from CARB's CMP Guidelines, Chapter 8 – Locomotives, pertinent to the AQMD PA.**

This chapter presents program criteria for locomotive projects, and provides an overview of the locomotive industry, locomotive emissions, current emission control requirements, and types of incentive projects eligible for funding. The chapter also sets requirements for installation of an idle-limiting device (ILD) on project locomotives, defines criteria for hybrid and multiple engine technology switcher projects.

## I. Introduction

Locomotives move more than 40 percent of the freight in the United States, on a ton-miles basis [Association of American Railroads, 2004]. Most locomotives operating today are diesel-electric, using a diesel engine to drive a generator, which in turn drives the locomotive wheels. Locomotive engines have very long useful lives, with the capability of being rebuilt numerous times.

Locomotives provide line-haul, short-haul, switcher, and passenger service. Each of these locomotive types has discrete functions and characteristics:

- Line Haul -Line-haul locomotives typically transport goods between major urban centers, sometimes up to 3,000 miles apart. Line-haul locomotives operate at higher speeds than other locomotives and generally utilize engines with 3,000 or

[3] The information below is excerpted from CARB's 2005 CMP Guidelines. Not all sections of the guidelines were pasted here, but CARB numbering was retained to stay consistent with CARB Guidelines for easy cross-reference.

greater horsepower. Because reliability is important for line-haul operators, these locomotives tend to be newer and well-maintained.

- Short-Haul -Short-haul locomotives perform a combination of line-haul and rail yard service. Typically, they use 2,000 to 3,800 horsepower engines, and move freight regionally or locally. For the purposes of the Carl Moyer Program, short-haul locomotives are treated the same as line-haul locomotives.
- Switcher -Switch locomotives separate and move railcars from track to track or transfer cars to and from regional carriers. Typically, they use 1,500 to 2,300 horsepower diesel engines, travel short distances at low speeds, make numerous stops, and idle frequently for long periods of time. Switcher locomotives are generally remanufactured from aging line-haul locomotives. Switchers are typically the oldest and most poorly maintained locomotives.
- Passenger -Passenger locomotives haul passengers rather than freight, and are typically used in high speed, line-haul type operations. The average passenger train is about 10 years old and has a 3,000 to 3,600 horsepower engine.

## III. Regulatory Requirements

The U.S. Environmental Protection Agency (U.S. EPA), with its sole authority to set emission standards for new and remanufactured locomotives, has adopted phased-in locomotive emission standards [Federal Register, April 16, 1998]. Federal locomotive emission standards contain two primary provisions: 1) remanufacture emission limits applicable to railroads whenever they remanufacture or rebuild their locomotive engines, and 2) emission standards for new locomotives applicable to locomotive manufacturers.

### A. Locomotive Remanufacture Emission Standards

Regulation of remanufactured locomotives is critical because locomotives are generally remanufactured five to ten times during their service lives. U.S. EPA's locomotive remanufacture emission standards therefore provide a mechanism to reduce emissions from the existing fleet. Federal locomotive remanufacture emission standards require locomotives originally manufactured in 1973 or later to meet the emission limits listed in Table 8-2 whenever they are rebuilt or remanufactured. Locomotives originally manufactured before 1973 are exempt from the federal locomotive remanufacture requirements.

**Table 8-2**

**Federal Exhaust Emission Standards for Locomotives for New Engines and at Time of Remanufacture (g/bhp-hr)**

| Duty-cycle | Gaseous and Particulate Emissions | | | |
|---|---|---|---|---|
| | HC | CO | NOx | PM |
| | Tier 0 (1973 – 2001 model years) | | | |
| Line-haul/ Passenger | 1.00 | 5.0 | 9.5 | 0.60 |
| Switcher | 2.10 | 8.0 | 14.0 | 0.72 |
| | Tier 1 (2002 – 2004 model years) | | | |
| Line-haul/ Passenger | 0.55 | 2.2 | 7.4 | 0.45 |
| Switcher | 1.20 | 2.5 | 11.0 | 0.54 |
| | Tier 2 (2005 and later model years) | | | |
| Line-haul/ Passenger | 0.30 | 1.5 | 5.5 | 0.20 |
| Switcher | 0.60 | 2.4 | 8.1 | 0.24 |

U.S. EPA locomotive remanufacture requirements also include an exemption for small railroads --line-haul railroads with fewer than 1,500 employees, and switch railroads with fewer than 500 employees. Surface Transportation Board (STB) freight railroad classifications, based on annual revenues, provide an equivalent mechanism for distinguishing between large and small railroads in California. STB freight and other railroad classifications, and the applicable U.S. EPA remanufacture requirements are as follows:

- Class I Railroads -Class I freight railroads are carriers with annual revenues greater than or equal to $266.7 million. Locomotives owned and operated by Class I railroads in California must meet the U.S. EPA remanufacture emission limits in Table 8-2. The Union Pacific Railroad (UP) and the Burlington Northern & Santa Fe Railroad (BNSF) are the only Class I freight railroad companies operating in California.
- Class II Railroads -Class II railroads are carriers with annual revenues between $21.3 and $266.7 million. Class II railroads are exempt from federal locomotive remanufacture requirements. Currently, there are no Class II railroads headquartered in California. For the purposes of the Carl Moyer Program, a Class II railroad locomotive must meet the same project criteria as a Class III railroad locomotive.

- Class III Railroads -Class III railroads are carriers with annual revenues less than $21.3 million. Class III railroads in California are largely exempt from federal locomotive engine remanufacture requirements. As a result, many older, unregulated locomotives continue to operate at Class III railroads.
- Military and Industrial Railroads – Over 100 military and industrial locomotives owned by non-railroad companies operate in California. These locomotives are generally much smaller in size and horsepower than locomotives used by larger rail yards, are confined to small yards or industrial plants, and are typically 40 to 60 years old. Military and industrial locomotives are largely exempt from federal locomotive remanufacture requirements. For the purposes of the Carl Moyer Program, military and industrial locomotives must meet the same project criteria as a Class III railroad locomotive.
- Passenger Service Railroads – Amtrak is California's only passenger locomotive operator not considered a small railroad by federal regulations. Amtrak is therefore the state's only passenger railroad subject to federal locomotive remanufacture requirements. Amtrak locomotives are currently required to meet all Tier 1 and Tier 2 emission limits, but are not subject to Tier 0 remanufacture requirements for their 1973 through 2001 model year locomotives until 2007.

The practical impact of the federal small railroad exemption from locomotive remanufacture requirements is that UP, BNSF, and Amtrak locomotives must meet federal remanufacture emission limits, while other railroads can remanufacture to uncontrolled emission levels.

### B. Emission Standards for New Locomotives

The second component of federal locomotive standards took effect in 2000, applies to locomotive manufacturers, and requires all new locomotives to meet the tiered emission standards in Table 8-2. Because these standards apply to locomotive manufacturers, all railroads, regardless of size, must purchase locomotives meeting Tier 2 emission limits when purchasing a new locomotive. In practice, however, only Class I railroads purchase new locomotives, while Class III railroads typically purchase existing in-use locomotives.

### C. Upcoming Regulations

In May 2004, U.S. EPA issued an Advanced Notice of Proposed Rulemaking, signaling its intent to pursue more stringent standards for new and existing locomotives [U.S. EPA, 2004]. The standards are likely to be modeled after 2007 and 2010 on-road and off-road diesel engine standards, and to be based on the application of catalytic after-treatment technology. The new locomotive standards could be phased in beginning as early as 2011.

### D. South Coast Locomotive Memorandum of Understanding

The Air Resources Board (ARB or "Board") and U.S. EPA have signed an enforceable Memorandum of Understanding (MOU) with UP and BNSF railroads to implement a locomotive fleet average emissions program in the South Coast Air Basin (SCAB). The purpose of the South Coast MOU is to expedite the introduction of new, lower-emitting locomotive engines in the SCAB. The agreement commits UP and BNSF railroads to

achieve a 5.5 g/bhp-hr locomotive fleet average NOx emission rate in the SCAB by 2010. The railroads can also get credit towards their 2010 fleet average target by exceeding the fleet average emissions targets between 2005 and 2009.

In order to ensure Carl Moyer Program funding achieves surplus emission reductions, railroads subject to the South Coast MOU must meet the following minimum project criteria:

- Locomotive projects in the SCAB may not be included in the MOU fleet average emission rate compliance demonstration.
- The project baseline emission rate for all locomotives in the SCAB subject to the South Coast MOU shall be equivalent to the Tier 2 emission rates identified for line-haul and switch locomotives in Table B-16.
- Class I freight railroad locomotive projects in all air districts, with the exception of the South Coast, must have a minimum project life of ten years.

This last requirement helps ensure that a cleaner locomotive funded in another air district cannot be exchanged for a dirtier locomotive in the SCAB at the completion of the project life to demonstrate compliance with the South Coast MOU. Allowing such an exchange, even at the end of the project life, could result in higher overall emissions since the locomotive exchanged into the participating air district could be dirtier than the original project locomotive.

### E. Statewide Locomotive Memorandum of Understanding

In June 2005, ARB signed a Statewide MOU with UP and BNSF railroads. The MOU requires UP and BNSF to install an ILD on over 99 percent of their intrastate locomotives between June 30, 2006 and June 30, 2008. The Statewide MOU also requires 80 percent of the diesel fuel dispensed to UP and BNSF locomotives in California to be low-sulfur diesel by the end of 2006. This agreement complements an ARB intrastate locomotive fuels regulation, adopted in November 2004, which requires all intrastate diesel locomotives to use California reformulated low-sulfur diesel fuel by January 1, 2007. The Statewide MOU also requires that railroads conduct health risk assessments at California's rail yards and consider additional long-term strategies to reduce idling PM emissions and health risks. Because the Statewide MOU requires virtually all UP and BNSF locomotives have ILDs, ILD projects for UP and BNSF locomotives are not eligible for Carl Moyer Program funding.

## IV. Potential Projects

Projects eligible for Carl Moyer Program incentive funding include repower or retrofit of an existing locomotive engine, purchase of a new reduced-emission engine or locomotive, or installation of an ILD. Hybrid and multiple engine switch locomotive projects have also received Carl Moyer Program funding in recent years and are eligible for funding. Other technologies that offer real emission reductions may also be considered on a case-by-case basis. Funding for projects considered on a case-by-case basis shall be contingent on a clear demonstration that the project shall achieve surplus, real, quantifiable, and enforceable emission reductions.

### A. Repower

A locomotive engine repower involves replacing an existing locomotive engine with a newer, lower-emitting engine. Locomotive repower projects must achieve at least a 15 percent NOx reduction beyond existing emissions levels. Repower projects for 1973 and later year Class III locomotives must achieve at least Tier 0-equivalent emission rates if a remanufacture kit certified by U.S. EPA to meet Tier 0 or lower emission levels is available. Baseline emissions for locomotive repower projects reflect federal emission requirements for engine remanufacture (e.g. Tier 0 through Tier 2 emission rates for Class I locomotives, and uncontrolled emissions for pre-1973 locomotives and Class III locomotives). Baseline costs for repower projects reflect the cost to remanufacture the project engine or $50,000, whichever is greater. All locomotive repower projects must include installation of an automatic engine start-stop (AESS) idle reduction device if the project locomotive is not already equipped with such a device and installation is technically feasible.

### B. Retrofits

Retrofits involve hardware modifications to the engine or exhaust system to reduce emissions. Potential retrofit projects involve the addition of an ARB-verified retrofit device, or installation of a U.S. EPA-certified remanufacture emission kit. For most Carl Moyer Program categories, a retrofit device must be ARB-verified in order to be considered for funding. To date, however, very few retrofit technologies have been verified to reduce emissions from a locomotive. Retrofit technologies generally develop first for on-road sources, and are refined for use on off-road engines. Because of the lack of retrofit devices verified for use on a locomotive engine, ARB will consider funding a locomotive retrofit device which is not yet ARB-verified for use on locomotives on a case-by-case basis. Applicants for funding on a case-by-case basis must meet the applicable project criteria identified in Section V of this chapter.

In recent years, engine manufacturers have also developed U.S. EPA-certified engine remanufacture kits for use on locomotives. To be eligible for Moyer Program funding, remanufacture kits must be U.S. EPA certified to achieve at least Tier 0 locomotive emission standards on the project locomotive engine. Remanufacture kit projects must also achieve at least 15 percent NOx reductions from the project locomotive if taking credit for NOx emission reductions. Kits which utilize fuel injection timing retard must be clearly demonstrated to not increase in-use PM or hydrocarbon emissions to be eligible for funding. Individual engine parts or other locomotive components are not eligible for funding except as part of a complete U.S. EPA-certified engine remanufacture kit.

### C. Idle-Limiting Devices

Locomotive operators idle their engines to maintain battery charge, warmth of the engine coolant, fuel, oil, and water, and comfortable temperatures inside the operator cabs. Locomotives also idle to ensure the engine is readily available (avoiding unnecessary starting and shutting-down), and because of habitual practice. Installation of an ILD can significantly reduce emissions from locomotives, which typically spend 40 to 60 percent of their operating time in the idle duty cycle.

The ILD technologies on the market today vary in operational requirements and predictability of idling reductions. The automatic engine start-stop (AESS) provides an automatic, fully integrated mechanism to reduce idling and does not rely upon a locomotive operator or require additional engines or infrastructure. An AESS typically uses a central computer to monitor vital engine parameters, such as battery charge, water temperature, and brake pressure, and automatically shuts off the engine after a set time. This technology is generally applicable to more locomotive types and operating conditions than other ILD devices.

Other ILDs include diesel driven heating systems (DDHS), stationary power plug-in units, and locomotive auxiliary power units (APU). These ILD technologies can reduce locomotive idling time under certain conditions. For example, a DDHS is particularly effective in colder climates, while a stationary power plug-in unit is feasible only for site-specific locomotives where plug-in technology can be permanently located. Costs for these ILDs range from $4,000 to $12,000 for a shore power plug-in unit, $8,000 to $15,000 for an AESS, and $25,000 to $35,000 for an DHSS or APU.

Because an AESS unit can provide significant and predictable air quality benefits at a relatively low cost, all locomotive projects without a functioning ILD must include installation of an AESS, if feasible, to receive program funding. The Carl Moyer Program shall pay actual equipment costs up to a maximum of $8,000 for the AESS and actual installation costs of the AESS up to $3,400. The award cap reflects the fact that AESS installation significantly reduces locomotive operating costs and has a typical capital payback period of one to three years. Other ILD technologies may be considered for program funding on a case-by-case basis if an AESS device cannot be installed on the project locomotive.

### D. Alternative Technology Switch Locomotives

In recent years, several diesel-electric hybrid switch locomotives have been funded through the Carl Moyer Program. Hybrid switch locomotives significantly reduce PM and NOx emissions, idling time, and fuel use compared to conventional switchers. These locomotives use the same basic concept as a gas-electric hybrid automobile --a battery pack powers the locomotive, while a small diesel engine runs as needed to keep the batteries charged. Hybrid locomotives typically utilize an aging locomotive frame and replace the existing large diesel engine, generator, and analog controls with a small diesel generator, battery pack, and computerized control module. The batteries can provide up to 90 percent of the locomotive horsepower at full load, while the remaining power comes from a 300 to 800 horsepower diesel engine. In addition to driving the locomotive, the added weight of the battery pack provides additional traction to propel the locomotive.

Switch locomotive projects which involve replacing the main engine with multiple heavy-duty truck or off-road engines have also become more commonplace. Multi-engine locomotive projects also typically involve significantly refurbishing an existing locomotive frame with new batteries, electronics, and controls. The replacement engines typically have a much lower horsepower rating and lower emissions than the engine they replace. For the purposes of the Carl Moyer Program, hybrid and multiple engine switchers, as described above, are defined as alternative technology switchers.

Switch locomotive purchase practices are unique. Few new locomotives are manufactured and purchased by the railroads for use in switcher service. Instead, as line-haul locomotives get older and less reliable, they are remanufactured for switching service and moved to a rail yard. In many cases, Class III railroads will purchase older switchers when they are retired by Class I railroads. Because railroads do not typically purchase newly manufactured switcher locomotives, an alternative technology switcher is considered a new locomotive purchase for the purpose of the Carl Moyer Program.

Baseline project emissions and costs for alternative technology switchers also reflect differing Class I and Class III regulatory requirements and purchase practices. Since Class I railroads are required to meet federal locomotive remanufacture emission standards for 1973 and newer locomotives, a new Class I switcher would typically emit at Tier 0 emission rates. Class III railroads --which are not subject to federal requirements and typically purchase older, in-use locomotives --typically remanufacture to uncontrolled emission levels. Baseline emissions for hybrid and multiple engine switcher projects at Class I and Class III railroads therefore reflect Tier 0 and uncontrolled emission rates, respectively.

The Carl Moyer Program may fund up to 60 percent and 80 percent of the total cost of an alternative technology switcher for Class I and Class III railroads, respectively.

Project funding caps reflect the differential cost of a typical switcher purchased by Class I and Class III railroads, as described above. Funding caps have also been set in recognition that an alternative technology switcher achieves significant fuel cost savings over its lifetime relative to a traditional switch locomotive.

U.S. EPA requires new switchers with an aggregate engine power rating greater than or equal to 1,006 horsepower to be certified to meet federal locomotive emission standards. An alternative technology switcher with federal locomotive certification must be evaluated based upon its certified locomotive emission rate. If federal locomotive certification is not required or not yet complete, the switcher may be evaluated and considered for Carl Moyer Program funding based upon the project engine's on- or off-road engine certification. However, alternative technology switchers must meet all federal certification requirements before program funding can be distributed to the project participant. Federal locomotive certification must demonstrate the locomotive emits NOx at a rate at least 30 percent below the Tier 2 locomotive emission standard.

## V. Proposed Project Criteria

These criteria provide the minimum requirements for all Carl Moyer Program locomotive projects. Participating districts retain the authority to impose additional requirements in order to address local concerns.

### A. General

- Emission reductions obtained through Carl Moyer Program projects must not be required by or used to comply with any federal, state or local regulation, memorandum of agreement/understanding with a regulatory agency, settlement agreement, mitigation requirement, or other legally binding document. Inclusion

in a rail yard or port emission reduction plan, lease agreement, or other voluntarily adopted strategy does not exclude a locomotive project from funding eligibility, if such a project is not otherwise required.

- No emission reductions generated by the Carl Moyer Program shall be used as marketable emission reduction credits, or to offset any emission reduction obligation of any person or entity.
- No project funded by the Carl Moyer Program shall be used for credit under any federal or state emission averaging banking and trading program.
- Locomotive operators utilizing an alternative emission control plan (AECP) to comply with California's locomotive low-sulfur diesel fuel requirements shall not be eligible for Carl Moyer Program funds.
- Beginning January 1, 2007, all diesel locomotive projects must use ARB low-sulfur diesel fuel. Emission reductions and costs associated with use of ARB low-sulfur diesel shall not be included in project cost-effectiveness calculations.
- Projects must meet a cost-effectiveness of $14,300 per weighed ton of NOx + ROG + combustion PM10 reduced calculated in accordance with the CMP cost-effectiveness methodology.
- Carl Moyer Program grants can be no greater than a project's incremental cost. The incremental cost is the cost of the project minus the baseline cost. The incremental cost shall be reduced by the value of any current financial incentive that reduces the project price, including tax credits or deductions, grants, or other public financial assistance.
- The contract term for all locomotive projects must be equivalent to the project life. The project life is defined as the number of years used to evaluate project cost-effectiveness.
- Class I freight locomotive projects must have a minimum project life of ten years. All other locomotive projects have a minimum project life of three years. ARB may approve a shorter project life on a case by case basis. Projects with shorter lives may be subject to additional funding restrictions, such as a lower cost-effectiveness limit or a project cost cap.
- The maximum project life for a locomotive project is 20 years.
- Because of uncertainty in locomotive load factors, locomotive project activity must be based upon fuel consumption.
- Seventy-five percent of estimated annual miles traveled and annual fuel consumption must occur in the South Coast Air Basin.
- The energy consumption rate for a locomotive engine is 20.8 bhp-hr per gallon. The energy consumption factor for an on-or off-road engine used in a locomotive application is 18.5 bhp-hr per gallon.
- Carl Moyer Program funds cannot be use to pay for labor or parts used during routine maintenance.

- Class I locomotives subject to the South Coast MOU are eligible for Carl Moyer Program funding only if such locomotives are excluded from the fleet average emission rate calculations which demonstrate compliance with the MOU provisions. The baseline emission rates used to determine emission reductions and cost-effectiveness for these locomotive projects reflect the Tier 2 emission rates for line-haul and switch locomotives identified in Table B-16. Locomotives subject to the South Coast MOU which receive Carl Moyer Program funding are ineligible to receive fleet average emission credits.
- Military and industrial locomotives and locomotives owned or operated by Class II railroads use the same Carl Moyer Program criteria as Class III railroad locomotives.
- Locomotive engine emissions, if based on emissions testing, must be determined following the most current and approved U.S. EPA emission testing procedures for locomotives.
- For all liquefied natural gas-diesel or other dual fuel locomotive projects, an EMU must be used to electronically monitor activity and fuel consumption by fuel type.
- Potential projects which fall outside of these criteria may be considered on a case-by-case basis if evidence provided by the air district suggests potential surplus, real, quantifiable and enforceable emission reduction benefits.

**B. New Purchase**

- Purchase of a new locomotive must achieve federal Tier 2 locomotive emission standards for PM and hydrocarbon emissions, and a NOx emission rate at least 30 percent below Tier 2 locomotive emission standards.
- For the purposes of the Carl Moyer Program, an alternative technology switcher is defined as a hybrid (e.g., Green Goat) or multiple engine switcher in which an existing locomotive chassis is significantly refurbished with a new engine, brakes, electronic controls, and/or other equipment. An alternative technology switcher project is considered a new locomotive purchase and must meet all emission criteria for a new locomotive purchase. Other switch locomotives may be considered for funding as an alternative technology switcher on a case-by-case basis.
- Baseline emissions for an alternative technology switcher project reflect Tier 0 emission rates for Class I locomotives and uncontrolled emission rates for Class III locomotives. The cost of an alternative technology switcher eligible for Carl Moyer Program funding shall not exceed 60 percent of the total cost of the new switcher for Class I railroad switchers, and 80 percent of the total cost of the new switcher for Class III railroad switchers.
- Baseline emissions and costs for a new locomotive purchase project which is not an alternative technology switcher reflect Tier 2 emission rates and the cost of a new Tier 2 locomotive, respectively.
- An alternative technology switcher with federal locomotive certification must be evaluated based upon its federally certified locomotive emission rate;

alternatively, if federal locomotive certification is not required or not yet complete, the project may be evaluated and considered for funding based upon its on- or off-road engine certification. If not federally certified, locomotives may on a case-by-case basis utilize NOx emission rates associated an ARB determination of an Ultra-Low Emission Locomotive under the South Coast MOU. Locomotives must meet all federal certification requirements before funding can be distributed to the project participant.

**C. Repower**

- Locomotive repower projects must achieve at least a 15 percent NOx reduction beyond existing emission levels.
- Baseline emissions for a locomotive engine repower are based upon federal emission requirements for engine remanufacture (see Section III of this chapter) and the corresponding emission rates in Table B-16. Baseline costs for a locomotive engine repower equal the actual remanufacture cost or $50,000, whichever is greater.
- 1973 and later model year Class III locomotives must achieve at least Tier 0 emission levels, if Tier 0 remanufacture kits are available.
- Alternative-fueled engines must be ARB-or U.S. EPA-certified to achieve a reduced emission level in a locomotive application. Alternative-fueled engines not certified to achieve a reduced emission limit in a locomotive application may be eligible for funding on a case-by-case basis.

**D. Retrofit**

- A retrofit device must be ARB-verified to reduce emissions from the project engine in order to be eligible for funding. Non-verified technologies may be considered on a case-by-case basis if: 1) an application for verification of the retrofit or add-on equipment on the proposed engine category is pending, 2) the retrofit or add-on equipment has been verified or certified by ARB or U.S. EPA for use on a similar engine category, or 3) project emission benefit, durability, and applicability have been or shall be demonstrated through in-situ testing.
- Retrofits considered for funding on a case-by-case basis must be clearly demonstrated to achieve the expected emission reductions for the full project life, function properly under the project locomotive engine duty cycle, and to not harm the locomotive engine.
- Remanufacture emission kits must achieve at least a 15 percent NOx reduction and be U.S. EPA certified to achieve at least Tier 0 locomotive emission standards on the project locomotive engine. Emission kits must be demonstrated not to increase in-use emissions of NOx, ROG, or PM emissions. Individual engine parts or other locomotive components are not eligible for funding except as part of a complete U.S. EPA certified engine remanufature kit.

## COST-EFFECTIVENESS FOR LOCOMOTIVES

Emission reduction benefits represent the difference in the emission levels of the existing baseline technology relative to the newer, reduced-emission technology. Baseline and reduced engine emission factors are listed in Table B-16 in Appendix B.

As mentioned earlier, an AESS ILD is required for all locomotive projects if feasible (except for alternative technology switchers). An Idle-Limiting Device Emission Reduction Factor, identified in Table B-17, is used to account for the air quality benefits of reduced idling.

Hydrocarbon (HC) emissions or emission limits for diesel locomotive technologies must be converted to ROG emissions based upon the following formula:

$$HC = ROG * 0.98$$

A detailed description and examples of how to calculate cost-effectiveness can be found in Part IV, Appendix D of the 2005 CMP Guidelines. Locomotive emission reduction calculations will use either the fuel-or hour-based formula as discussed in Part IV, Appendix C.